

The utilization of a central processing office suffered from the problem of "no local knowledge", in which knowledge of local streets and terrain as well as EMS services was lacking. Moreover, the cost for the Code Alarm system at the time was \$35 per month for the dedicated cellular phone, which was incapable of making calls other than emergency calls. An additional \$40 per month service charge was also imposed for the dispatch operation. As a result, consumer acceptance was lacking.

TRIANGULATION SYSTEMS

In an attempt to identify the location of stricken individuals utilizing cellular phones, Pac-Tel developed its Teletrack system, a triangulation system in which the cellular phone location was identified through the utilization of a ranging technique and a transponder at the cell phone. Problems involved with the Teletrack system include an estimated implementation cost of \$500K per cell site, along with a deployment time of approximately two years per community, making the system relatively expensive and neither universal nor quickly implementable.

Subsequent to Teletrack's deployment, Sanders Associates of Nashua, New Hampshire developed a time difference of arrival (TDOA) technique in which a data burst is received simultaneously at three cell sites. From the time difference of arrival of the data burst from the phone at each of the cell sites, the approximate location of the cellular telephone can

be received. The approximate cost of the Sanders system is \$90K per cell site and two years per community to implement.

A pure direction finding system was implemented by KSI of MacLain, Virginia at an approximate cost of \$50K per cell site and 18 months per community to implement, with the position being acquired through the utilization of direction finding techniques, as opposed to time difference of arrival techniques (see Figure 2).

Most recently, the Associated Group has implemented a TDOA system, dubbed their True Position System. This system is presently being tested by the New Jersey State Police with participation from ComCast, MapInfo, On Target Mapping, Rockwell, Bell Atlantic, and the KML Group to ascertain location accuracy and cost of implementation. The estimated cost is \$50K per cell site, but varies depending on the number of receivers (1-6) per cell site (see Figure 3).

As with any triangulation system, when the cell sites are in line, the lines between the towers and the cell phone come together at very shallow angles, reducing the accuracy with which position can be ascertained. Secondly, as with all triangulation systems, the coverage depends on towers being retrofitted with suitable antennas and infrastructure. For example, in Boston, there are 100 cell sites per side (A, B) making the cost per side, even with the least expensive of the present systems, on the order of \$5 - \$10 million. This does

not take into account PCS with two additional sides and many more cell sites. Moreover, the time to obtaining a fix can be as long as two minutes.

Bob Miller, New Jersey Office of Emergency Telecommunication Services, unequivocally states in his comments to the current FCC NPRM, that triangulation systems will cost New Jersey \$100 million to implement. This is over \$5 billion nationwide based on multiplying the \$100 million figure by 50.

Also important is a civil liberties problem with all triangulation systems and that is the "big brother is watching you" problem, since the system is capable of locating the position of all cell phones, whether the individual wants to be found or not. Research shows that an individual wants to be found only when he/she wants to be found, whereas cell phones are locatable 24 hours a day through the utilization of a triangulation system.

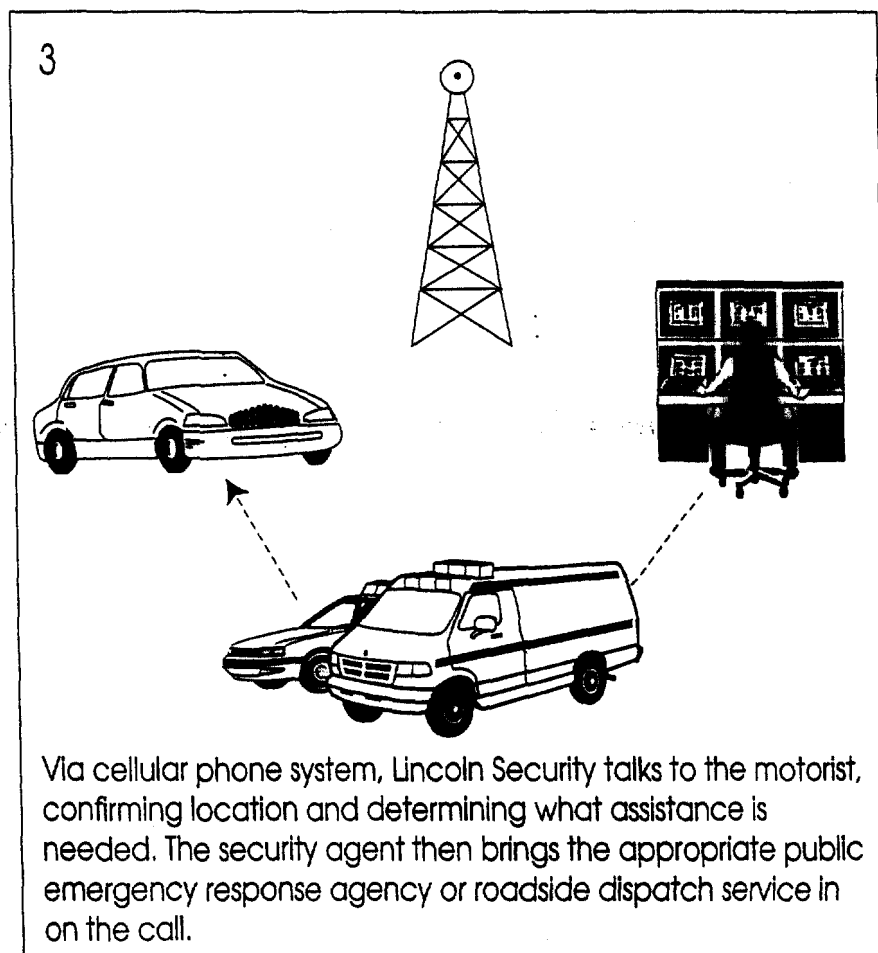
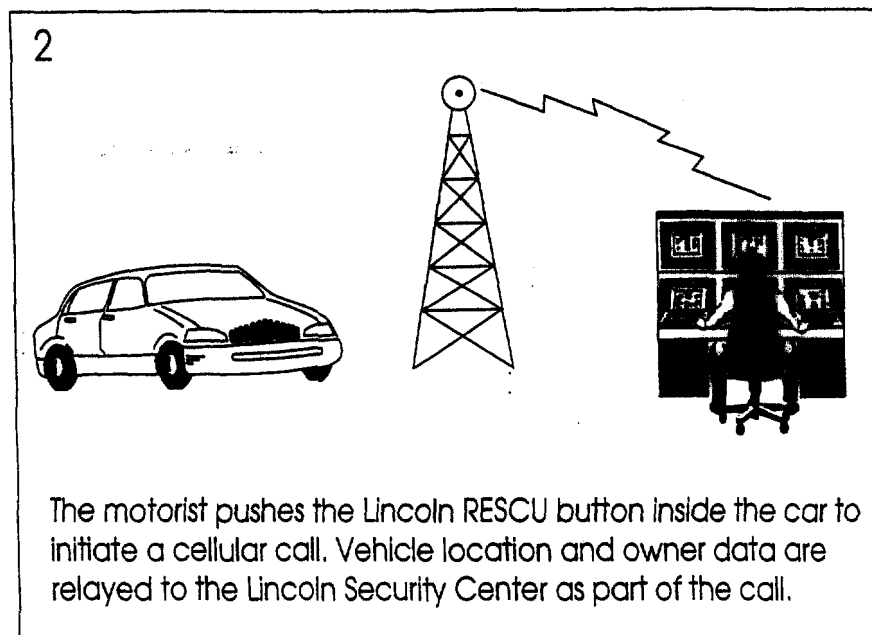
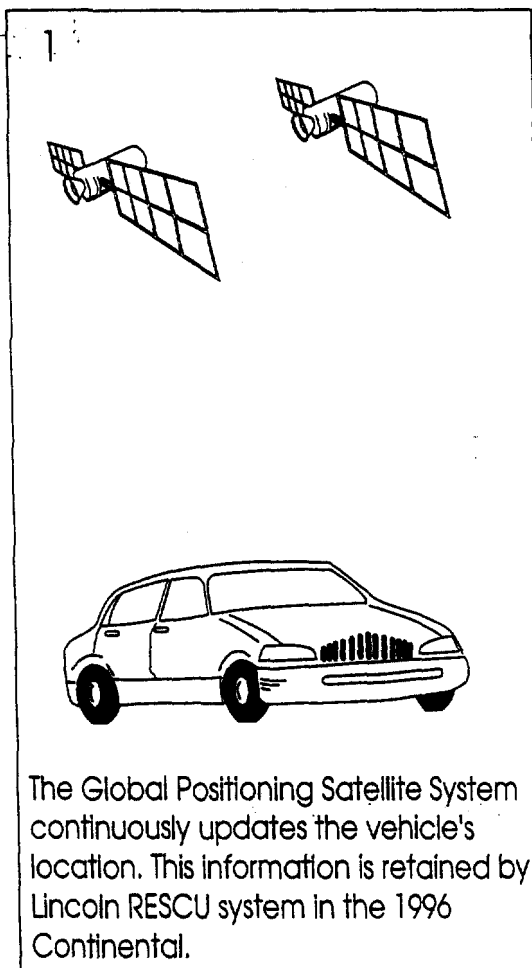
GPS SYSTEMS

While triangulation systems suffer from infrastructure costs and deployment schedules, Global Position Satellites provide universal coverage, although non-operational in buildings. In order for GPS receivers to operate, the 40 watt spread spectrum signals from the 26 satellites must be receivable by the GPS receiver on a line-of-sight basis. It has been found that cloud cover, trees, and other blocking artifacts other than buildings seem to have very little effect

on the receipt of these signals which are 20 dB down by the time they reach the earth's surface. In general, as many as 8-12 GPS satellites are visible from any particular point on the earth, with the result that manufacturers such as Motorola, Garmin, Trimble, Magellan, Rockwell, and others have provided 8-12 channel receivers for the receipt of the GPS signals. The satellites provide signals indicating their own position, e.g., ephemeris, and timing signals such that the GPS satellite receivers can derive range to each of these satellites from which the position is internally calculated by the GPS receiver.

One early system utilizing GPS information to provide a PSAP with the location of a stricken vehicle was developed by Navsys Corporation of Boulder, Colorado in which raw GPS data received by a GPS antenna mounted on the exterior of a car was transmitted to a central processing point provided by Navsys and the Department of Transportation for the State of Colorado to process the GPS information and to provide location to PSAP terminals within the State of Colorado. While the utilization of GPS-based location information proved adequate to locate the vehicles in question, the utilization of a central processing facility to process raw GPS data was found to be unwieldly, also limiting the portability of the system to other jurisdictions.

Noting the present development of miniaturized GPS multi-channel receivers, Motorola developed the Encore system



for the location of vehicles initially implementing the system in Lincoln automobiles (see Figure 4). These systems were implemented through the utilization of a cellular phone coupled to the output of the Encore 8-channel GPS receiver, with the latitude and longitude location being modemed to Westinghouse in Irving, Texas for further dissemination to the closest PSAP to the vehicle. The system was initially configured to provide the PSAP with the Vehicle Identification Number and position information only, with this information provided to the relevant PSAP by calling a back line at the PSAP.

Note, the initial Rescue system did not, however, provide voice communication between the stricken vehicle and the PSAP, a situation which has subsequently been corrected.

In an effort to ascertain back-up line telephone numbers, Westinghouse turned to the National Emergency Number Association or NENA for the provision of the telephone numbers of the local PSAPS. Presently, the accuracy of such PSAP numbers is at the 80% level, as there are some 7,000 PSAPS in the United States. The utility of modeming information to a central processing dispatch center such that as maintained by Westinghouse is that the amount of infrastructure to be provided at the PSAP can be limited.

Consumer acceptance of the Encore Rescue system is presently in question as the system is currently marketed. For instance, as of the date of this paper, the Rescue system is \$1,500 per install, plus \$100 per year monitoring fee, both amounts somewhat limiting sales.

In an effort to establish standards for E-911 signalling utilizing GPS receivers, in 1995 the Intelligent Vehicle Highway System (now ITS or Intelligent Transit System) under the direction of Dr. Christine Johnson, promulgated an operational test funded by the National Highway Public Safety Administration in which Calspan was the lead participant and which other participants included the Erie County Sheriff's Office, Cellular One, GM and AAA. The goal was to provide a system for determining not only the location of a stricken vehicle and time of crash, but also its change of velocity and direction of impact, its point of impact, the force of impact, and other details relating to the crash of the vehicle. The contract was let for \$305 million, with the deployment in 1000 vehicles scheduled for early 1997.

PERSONAL PORTABLE UNITS

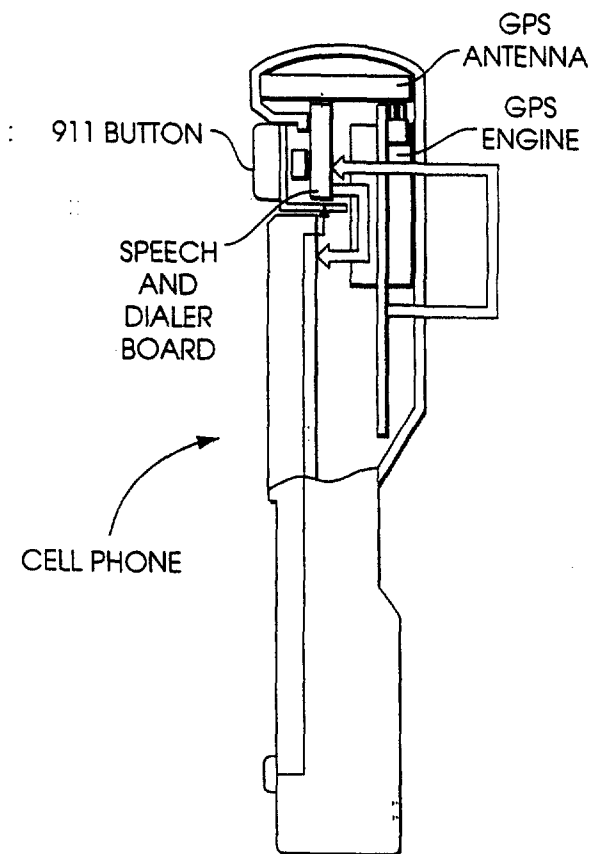
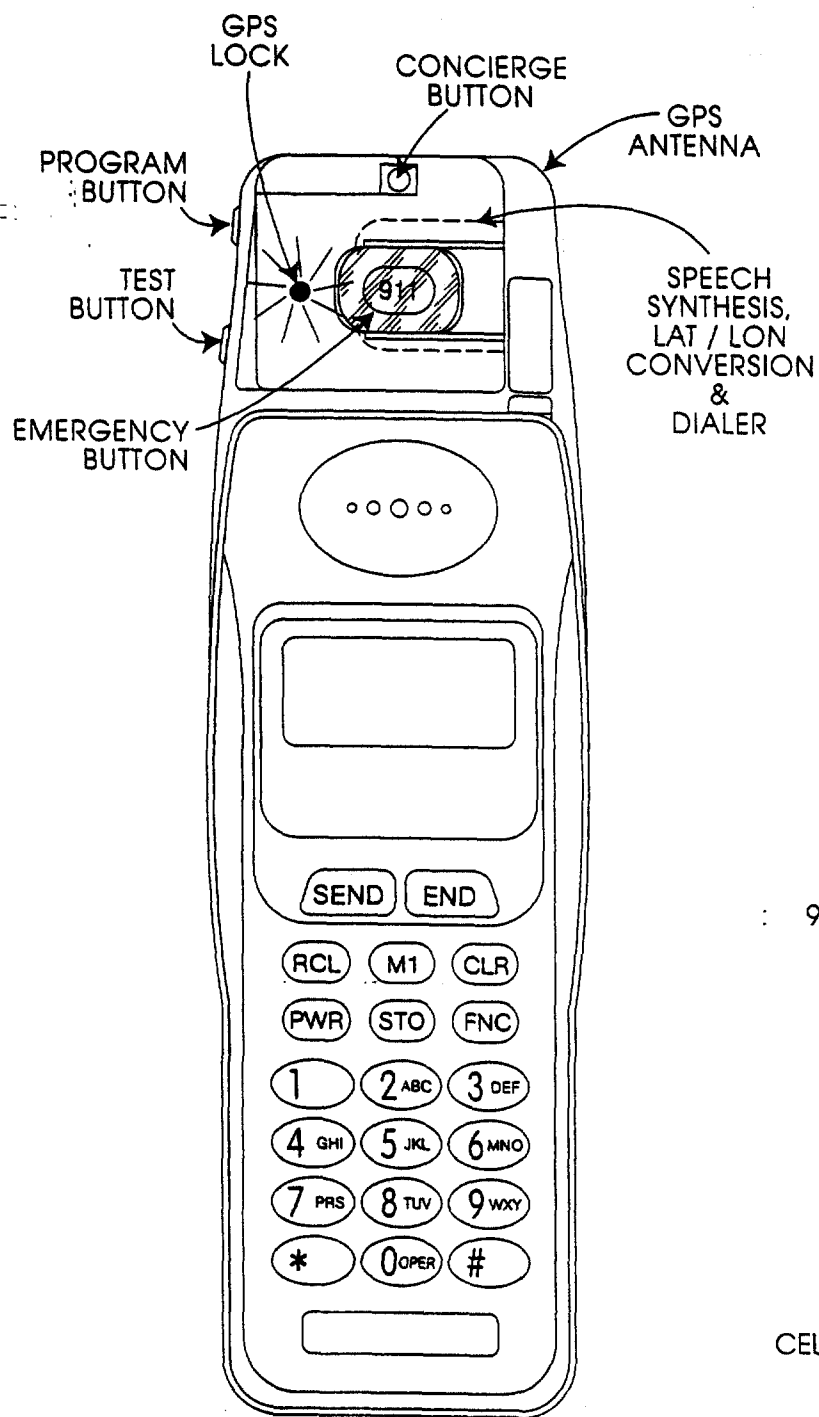
As with any vehicle location identifying system, there remains the question of the ability to provide location information for cell phone users who are not within a vehicle. It is estimated that there are now 40 million cellular telephone subscribers in the United States, with the cell phones being freely portable and with sales statistics indicating that less than 10% of the phones currently sold are for in-vehicle install. There is, therefore, a requirement for the ability to locate cellular E-911 callers outside of a vehicle, a task currently performed by the above-mentioned triangulation systems.

FONEFINDER

As an outgrowth of the MayDay Mike marine implementation for locating stricken vessels at sea, Tendler Cellular of Boston, Massachusetts has developed an integrated, portable, unitary cellular phone incorporating a GPS receiver, a GPS antenna, a chipset for decoding the latitude and longitude derivable from the GPS receiver, and a synthesized voice indicating location (see Figure 5). The salient features of the FoneFinder system are that it is instantly implementable with the provision of the cellular phone, universal in coverage, and can be made available by the carriers at the cost of a normal cell phone, plus \$4 per month and a three-year no-cut contract. A block diagram of the system can be seen in Figure 6, with optional activations for car theft alarm, airbag deployment, man down, hijack and pager scenarios.

The utilization of synthesized voice to announce the latitude and longitude of the E-911 caller results in a virtually infrastructureless system in which, through the provision of electronic maps on CD-ROM at a cost of no more than \$300 per terminal, operators at the PSAPS can obtain a bulls-eye on the electronic chart by merely listening to the latitude and longitude, typing it in and receiving the bulls-eye.

Testing of the FoneFinder system is currently planned by several carriers and by AirTouch in the Los Angeles County area, with cooperation from the public safety officers of each



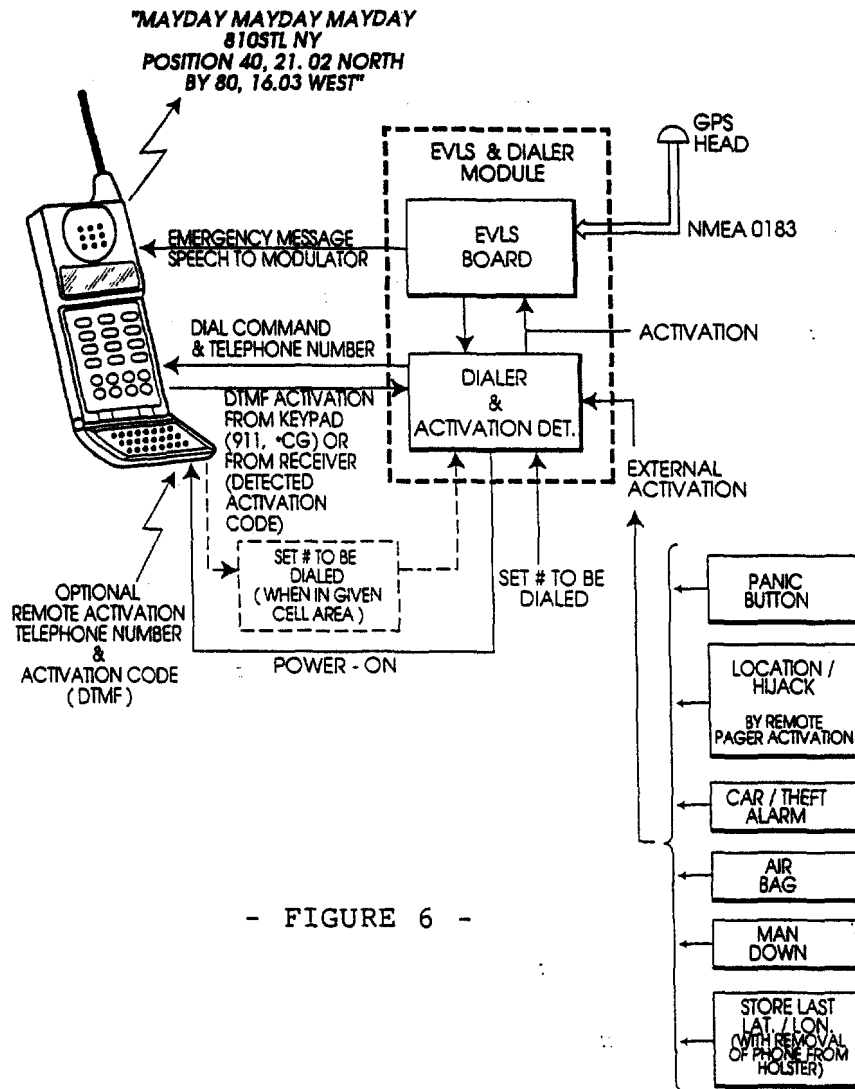
- FIGURE 5 -

of the communities. In addition, a test of a 911 Back-up Service (see Figure 7) is planned for the Massachusetts, New Hampshire, Vermont, and Rhode Island areas in combination with The Cross Country Group, a road-side assistance dispatch organization, which, after the 911 call has been completed to the PSAP, provides a back-up service to the customer to assure that help is on the way.

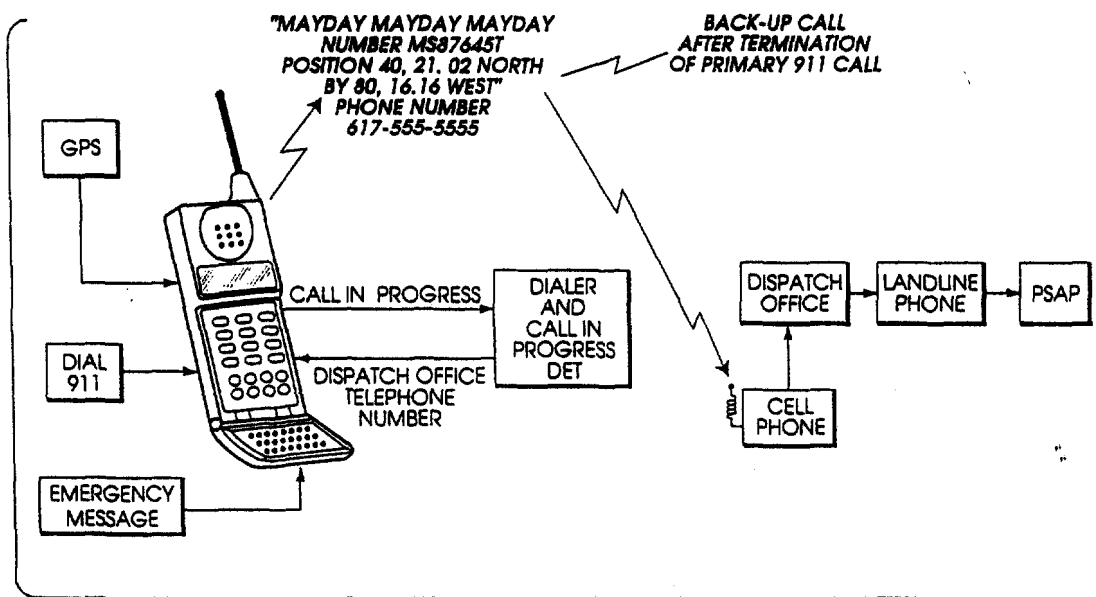
Additionally, Concierge and other services can be provided since the location of the cell phone is readily available, with the Concierge call being placed by the touch of a Concierge button to a dispatch center such as AAA, Westinghouse, or The Cross Country Group for providing such services as locating the nearest gas station, pharmacy, movie theatre, or ball score (see Figure 8).

The FoneFinder system, as presently contemplated, involves a cost to the dealer of the cell phone at about \$150, to which is \$165 added to the cover cost of the FoneFinder system including the GPS receiver, antenna, and FoneFinder. This makes the cost to the dealer on the order of \$300 - \$350. For \$4 per month and a no-cut three-year plan, the FoneFinder phone can be made available "free" to the customer, subsidized by the carrier in the normal fashion, with the no-cut contract eliminating "churn" in the cellular industry, a \$2 billion a year headache.

The \$4 per month charge for the FoneFinder system, plus revenues available from the 911 Back-up Service as well as the

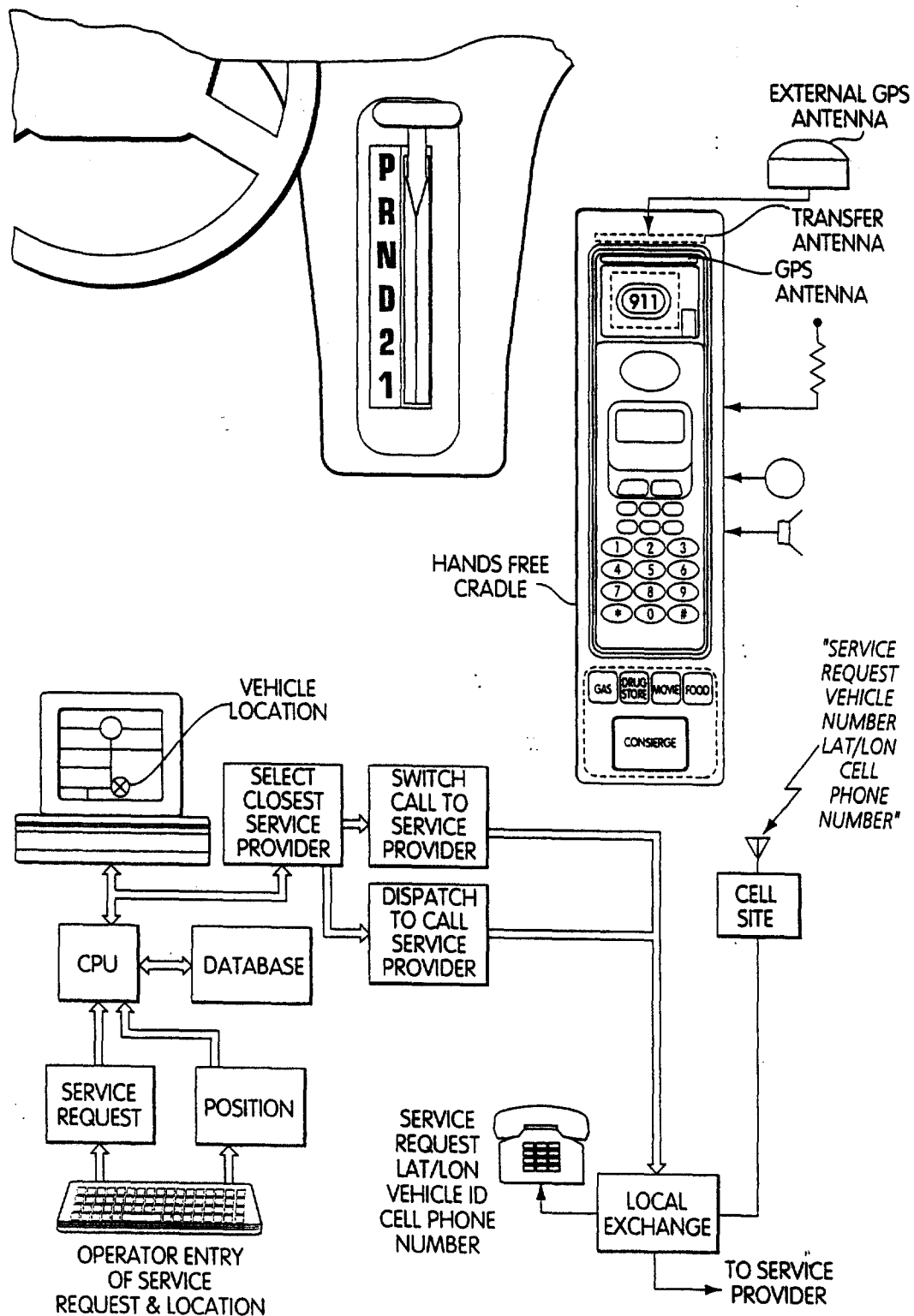


- FIGURE 6 -



911 BACK-UP SERVICE

- FIGURE 7 -



- FIGURE 8 -

concierge services, provide a significant revenue stream back to the carrier to permit the carrier to provide FoneFinder phones "free". This enables assured deployment, satisfaction of the Report and Order of the FCC, and, most importantly, a solution to an urgent public safety need.

The FoneFinder system, in addition to calling out the latitude and longitude, also calls out the time-since-last-fix so that PSAP operators can ascertain whether or not the latitude and longitude that is being called out and stored at the cell phone is in fact valid. The operators can also ascertain by the time-since-last-fix whether or not the individual is in a garage or in a building, thus to eliminate the problem of the inability of the GPS receiver seeing the satellites. As an optional additional feature, the cellphone calls out the velocity and direction so as to further assist PSAP operators in finding stricken individuals.

While not the subject of the present paper, the FoneFinder system also calls out the cell phone number or ANI of the cell phone, thereby solving the problem of providing the Mobile Identification Number or MIN to the PSAP. It is important for PSAPS to be able to recall cellular 911 callers on the occasion of a dropped call. It is for this reason that the Report and Order requires a relay of the caller's Automatic Identification Number (ANI) or the location of the cell site receiving the 911 call to the PSAP so that the PSAP can call back the closest cell site to pick up the dropped call. It has been proposed

that this be accomplished by providing Pseudo ANIS (referring to the telephone number of the receiving cell site) in a complicated infrastructure-intense system estimated to cost the PSAP on the order of 75¢ per minute to cover infrastructure costs.

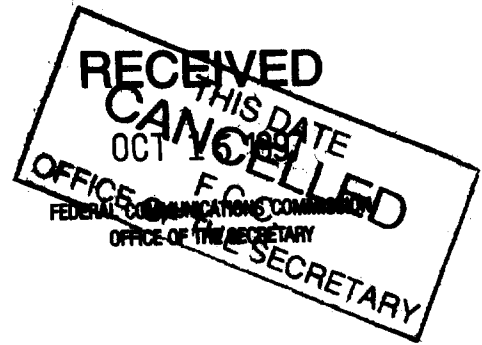
On the other hand, the FoneFinder system simply announces in English through synthesized voice, the caller's telephone number or MIN.

The FoneFinder system thus provides an instantly deployable, universal and a "free to the public" system for solving an urgent public safety problem.

APPENDIX C

TENDLER Cellular

Robert K. Tandler, Chairman



August 19, 1996

Office of Secretary
Federal Communications Commission
919 M Street, N.W.
Washington DC 20554


RE: Comments to the Further Notice of Proposed Rulemaking
CC Docket No. 94-102; RM 8143

Dear Sir/Madame:

Enclosed herewith are comments to the Further Notice of Proposed Rulemaking adopted June 12, 1996 from Tandler Cellular, Inc.

It would be appreciated if the Commission would consider these comments.

Respectfully Submitted,


Robert K. Tandler
Chairman

RKT:lpc

enclosures, original and 9 copies

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington D.C. 20554

In the Matter of)
)
Revision of the Commission's Rules) CC Docket No. 94-102
To Ensure Compatibility with) RM-8143
Enhanced 911 Emergency Calling Systems)

To: The Commission

REPLY COMMENTS BY TENDLER CELLULAR, INC.
TO THE FURTHER NOTICE OF PROPOSED RULE MAKING

INTRODUCTION

Prior to commenting on position accuracies and the speed with which automatic location information can be provided with present day technology, Tendler Cellular's role in the initial NPRM is now discussed. In response to the Notice and Order dated July 26, 1996 Tendler Cellular to notes that the requirements for ANI and ALI are now in place. In it's initial submission dated December 29, 1994 to the original NPRM concerning the location of E-911 cellular callers, Tendler Cellular commented favorably on the ability to meet the requirements for ALI (Automatic Location Identification) through the utilization of GPS Technology coupled with voice synthesis technology to verbally report in spoken language and in real time the latitude and longitude of a cellular telephone equipped with a GPS receiver and the synthesized speech

technology. The system also verbally reports the mobile identification or number or MIN, eg the cell phone number. The verbal communication of lat./lon. plus verbal communication of cell phone number satisfies the above identified Report and Order for new phones.

It is noted that the provision of such technology requires no infrastructure in order to report to the PSAP the latitude and location of the E911 caller. As a result, while the Report and Order is contingent upon cost effective technology, it is Tandler Cellular's position that presently-available cost-effective technology exists and will be available by year's end in a unitary hand held cellular phone and in a handsfree cradle version in which the GPS receiver and the synthesized voice technology is incorporated in the cradle.

ACCURACY

Attention is now turned to the main focus of the Further NPRM which, inter alia, seeks comments as to the technical feasibility of 10 meter accuracies for location of cellular E-911 callers. This accuracy can be achieved by the present GPS system if Selective Availability is turned off.

Selective Availability or S/A refers to the intentional degradation of position information obtained from GPS satellites obtained by dithering the pseudo range value transmitted by the GPS system such that the accuracy is no better than 100 meters with S/A turned on. The entity which

has control over the turning on or off of S/A is "The National Command Authority", eg. the President of the United States.

Positional accuracy of the GPS system as well as the Russian GLONASS system is regularly monitored. For instance, Lincoln Laboratories at MIT (See Exhibit A) regularly records a scatter pattern indicating the positional accuracy of both the GPS satellites, GLONASS satellites, and GLONASS satellites enhanced with the superior time clocks of the GPS satellites. The Internet web site for this information is as follows:

<http://satnav.atc.ll.mit.edu/>

Note that The Honorable Edward M. Kennedy was successful in cosponsoring an amendment to the Defense Authorization Act to require S/A to be turned off by May 1, 1996, unless the DOD put together a Research and Development program to address this issue. (See Exhibit B H.R. 1530). Just prior to this deadline the DOD promulgated an RFQ for the above-identified research, thus removing the May 1, 1996 deadline. (See Exhibit C PSA-1549)

Thereafter The White House issued a Presidential Decision Directive or PDD, announced March 29, 1996 by Vice-President Al Gore (See Exhibit D) which set as a goal the elimination of S/A "within a decade". Citing commercial applications, the Directive specified that the GPS system would be made available to the public and would be maintained by the DOD, as opposed to the Department of Transportation or Commerce.

Were Selective Availability to be turned off, the accuracy for the current GPS system would be in the ten meter

range, clearly meeting the ten meter requirement of the Further NPRM.

In support of a decision to turn off S/A, the undersigned has authored two articles, one in Cruising World Magazine and one in Defense Conversion Newsletter (Appended hereto as Exhibit E) in which it is argued that there is no military requirement for S/A in view of the GLONASS satellites which signals are not dithered. In view of the availability of GLONASS receivers both within the continental United States and the through Russian governmental agencies, and in view of the ready availability of so-called Beacon receivers which when in place near a target provide signals for correcting the dithered signals, any perceived assistance to the military of the dithering evaporates.

Note these Beacon receivers are available from the Leica Corporation, the successor in interest to the beacon technology developed by Magnavox Corporation and provided to the U.S. Coast Guard.

As mentioned in one of these articles, it is interesting to note that in the Gulf War the United States through the Department of Defense turned off S/A to permit troops and tank commanders to find their position in the desert, in direct opposition to the stated goal of the S/A, namely to protect troops from hostile use of the GPS system.

As one final comment, in an effort to persuade the National Command Authority to turn off S/A, it is noted that the original system produced by the Rockwell Corporation has cost

the tax payers twenty-six million dollars initially, with the full compliment of twenty-six satellites now having cost the taxpayers six to seven billion dollars. President Clinton has indicated the desire to turn off S/A as indicated by the above Directive so that the taxpayers can reap the benefits of a system, originally generated for Department of Defense use, now having major commercial and recreational spin off.

The Problem is WHEN?

With the support of the Federal Communications Commission, it is deemed that the National Command authority can be persuaded to turn off S/A, thereby meeting and ultimately exceeding the positional accuracy requirements of the Further NPRM.

LOCATION REPORTING SPEED

The Further NPRM requests comments on the speed by which it is possible to report E-911 cellular phone location to a PSAP. While triangulation systems have an inherent computation overhead or time before calculating and reporting position, present GPS receivers have location information available on average once a second. This permits real time tracking of the GPS receiver and thus the phone if it is co-located with the receiver. Tests with the precursor to the FoneFindertm System, namely the Mayday Miketm system for marine VHF radios provided verbal updates of the position as quickly as they could be spoken. Thus in one embodiment with an approximate time of 10 seconds to speak the entire position sentence,

verbal updates could be obtained every ten seconds. Digital automation does not significantly improve this real time report of position compared to the one to two minutes required for some triangulation systems.

CONCLUSION

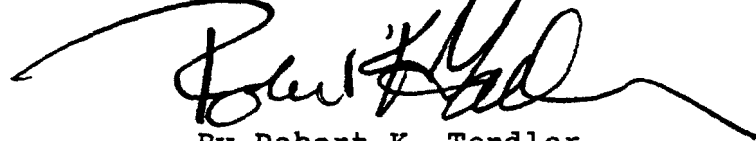
It is therefore Tandler Cellular's position that the technology presently exists for reporting the location of the E-911 cellular call to a PSAP in real time within the required ten meter range, should the National Command Authority turn off S/A. Alternatively, technology exists presently to acquire the GLONASS satellite signals, which signals have the requisite accuracy.

In summary, in view of the urgent public safety need for the location of cellular E911 callers, it is Tandler Cellular's position that the technology currently exists to meet the position accuracy and position reporting requirements of the Further NPRM, save only for the National Command Authority removing Selective Availibility. The removal of Selective Availability is appropriate insofar as there appears to be no military advantage view of the GLONASS satellites, GLONASS satellite receiver availability, and readily available Beacons.

Consideration of the above comments is respectfully solicited.

Respectfully submitted,

TENDLER CELLULAR, INC

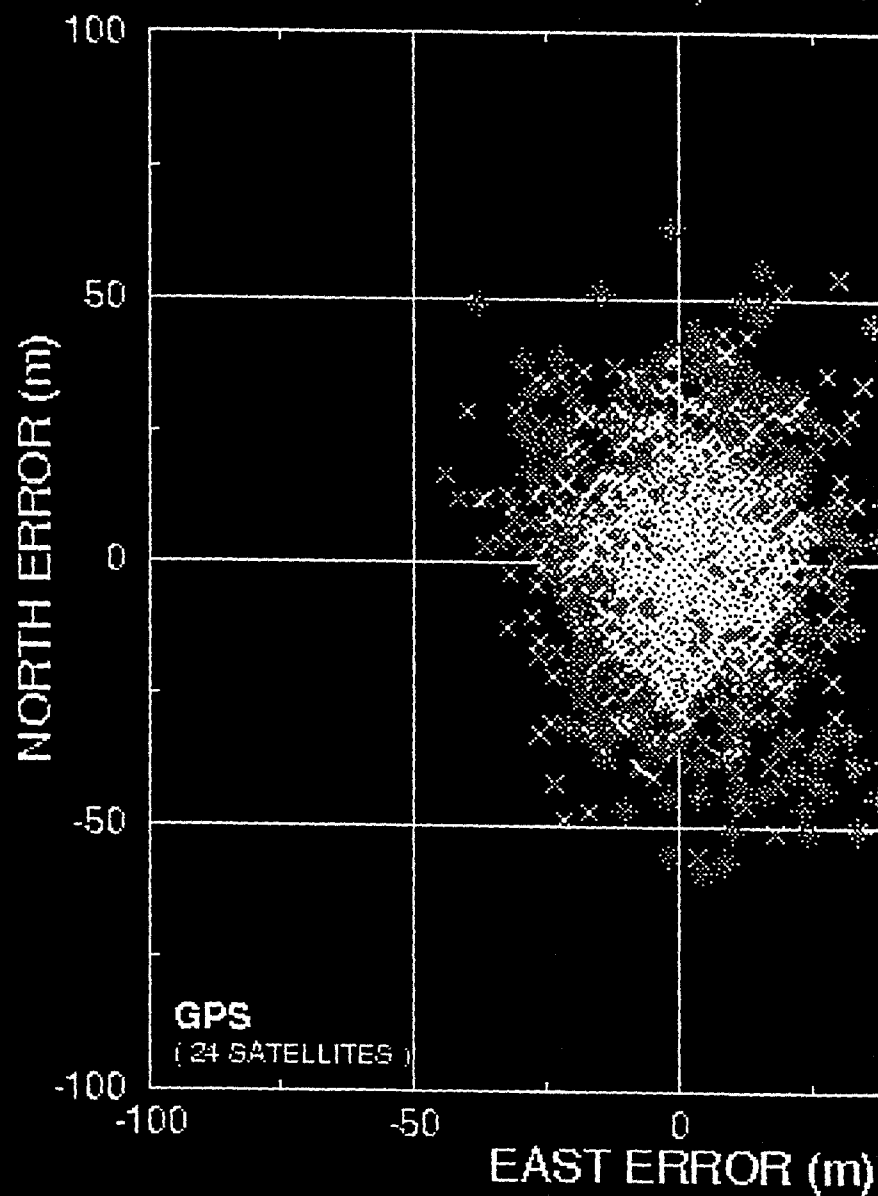
A handwritten signature in black ink, appearing to read "Robert K. Tandler", with a long horizontal flourish extending to the right.

By Robert K. Tandler
Chairman

EXHIBIT A

GPS POSITION ESTIMATE

1-MINUTE SAMPLES, 23 JANU



* AT LAT: N42:27:34, LONG: W71:15:54
SEE NOTES